

## LP GAS FRACK: AN ENERGY BREAKTHROUGH

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### ABSTRACT

Shale Gas extraction is a challenging task as it is contained within the shale formations<sup>1</sup> that are highly porous but impermeable in nature. There are a large number of synthetic processes that are undertaken to recover the natural gas from shales, such as hydraulic fracking. Some of these processes have a harmful impact on the environment because of the chemicals that are injected during the hydraulic fracking in the wells. The pressurized gas leakages can pollute the environment. According to a recent survey, Pakistan is the 19th in term of shale reserves in the world and has 51 trillion cubic feet (TCF) of shale gas reserves. Accordingly, shale gas may be an important factor in the future growth of the country. But unfortunately, due to a number of political, technical and other factors, these reserves are still unexplored. We have accordingly written this paper to introduce and uncover a latest technique which can be an inexpensive and safe solution in order to extract these reserves according to the commercially required quantities and without any detrimental impact to the environment. The method is particularly suitable because of the factors such as water protection, very low climate impact, induced seismicity in order to minimize the risk to public health and environment. This is an advanced technique which can replace the hydraulic fracking by which we can extract these shale gas reserves in a convenient way known as 'LP GAS FRACK Method'. This method enables formation of an aqueous solution of hydrocarbons which can run down through the hole. The specific properties of the solution have to be kept in consideration during the design process. This idea is taken from the distillation of crude products through which a hydrocarbons mixture (crude) produces hydrocarbons (by-products). This method is accordingly considered to be an effective method in order to utilize the hydrocarbons and produce the shale gas (which is also a hydrocarbons mixture) in a very safe and economical manner while protecting the health and environment.

**Keywords:** LP Gas Fracking, Shale Gas, Environmental Impact

### INTRODUCTION

Shale is a type of sedimentary rock which comprises of very small clay particles sometimes called

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<sup>1</sup> Shale is a fine-grained, clastic sedimentary rock composed of mud that is a mix of flakes of clay minerals and tiny fragments (silt-sized particles) of other minerals, especially quartz and calcite.

mud. These shales contain organic material. When broken, they are converted into oil and gas. When sediments are deposited at a depressed area (trench), organic matter is also deposited with them which is then calculated as the Total Organic Content (TOC). When this mud is buried deeply, it forms a layered rock called "Shale". Shales have some specific properties due to which these are considered to be important resources.

Matrix permeability (capability of the fluid to flow through them) of shales is very low as compared to the conventional oil and gas reservoirs (i.e. nanodarcy in shales versus milidarcy in conventional sandstones), therefore pores are completely filled with the hydrocarbons (oil and gas) and they are not capable of flowing under normal conditions, but can slightly migrate over long periods of time. The hydrocarbons movement is slow from shales into shallower sandstone or carbonate reservoirs. Shales have been considered as a source or seal rocks rather than potential reservoirs, although large quantity of hydrocarbons remain trapped within the pores of shale. Some of the wells that produce from unconventional shale formations may be the source for other gas reservoirs. A considerable amount of gas can be confined in fracture porosity, which exists due to tectonic movements where small existing pores coalesce to enhance permeability values.

Generally, LP Gas Fracking involves the use of a working fluid [1]. Hydraulic fracturing uses an injective fluid, usually water. It takes up to an average of 60,000 gallons of water per well to frack [2]. Water is used in the process as a potent fluid as it is incompressible when exposed to the high pressures.

Propane is a gas at normal conditions (room temperature and pressure) and therefore, it has different physical behaviour as compared to water. When it is cooled and pressurized, it can exist in incompressible gel-like phase. The LP Gas fracturing uses this gel instead of water to fracture the unconventional reservoirs and to provide a conduit for the hydrocarbon gasses to the surface.

Liquid propane gas fracking is a breakthrough development in the petroleum industry that can significantly boost the economy [3]. This enables the operators to use the already produced hydrocarbons to extract more hydrocarbons while reducing unnecessary infrastructure [4]. When liquid propane gas is mixed with the desired chemicals, it provides an unchangeable viscosity, so there is no requirement to use any CO<sub>2</sub> or N<sub>2</sub>, in any special venting and cool down system. LPG produced is stored in a vessel and kept at an ambient pressure. Its usage reduces the CO<sub>2</sub> emissions. As this has half the specific gravity of water, the trucking investments get reduced by up to 90%. In the past, since fifty years, LPG was used for conventional reservoirs but in this case, it can be used as a stimulation fluid to fracture the unconventional reservoirs. For instance, it was used for the stimulation oil wells stimulation and tight gas sands to improve the recovery efficiencies.

## 2. LITERATURE REVIEW

R. S. Lestz, a research engineer, during an offshoot work at Chevron in 1990's experimented with the nitrogen and carbon dioxide and came up with a brilliant idea to enhance the fracturing process [3]. He accordingly suggested the idea of LPG gel based frack process and acquired its patent. Safety and equipment procedures were developed during the process to cope with the volatile fluid (as it is flammable in nature and can pose process safety risks) including a vapor and pressure sensor system, infrared cameras, remote equipment operation and emergency gas release flares [3]. After

this development, the process was rapidly deployed at a number of locations to reap its extensive benefits. LPG technology was used to frack its first well in 2008. And afterwards, the GASFRACK Company has performed 1863 fractures of 857 locations as of spring 2013 [8].

## 2.1 HISTORY OF SHALE

Historically, Pakistan has not made any significant use of this technology so far due to a lack of attention, however still there is a long way to go for shale gas recovery in the country and this technology can be implemented. In April 2011, EIA reported that there were 206 TCF reserves present in the lower Indus Basin, of which 51 TCFs were technically recoverable. It is shown in the shale resource map (figure 1) that the reserves that are trapped within the shale reservoirs are located in Lower Indus Basin particularly in Rani Kot and Sembar region. In 2015, USAID confirmed the presence of 10159 TCF of shale gas reserves in Pakistan which are not explored till today. The availability of huge reserves can possibly lessen Pakistan's reliance on the imports and beat the present energy challenges. This would provide support to the industrial economy. However, this would only become possible when an uncompromised priority will be given to the investments required to develop the energy areas throughout the country. In Pakistan, 70% area is full of shale reserves now and one can expect if these reserves are utilized, there will be a massively positive effect on country's economy.

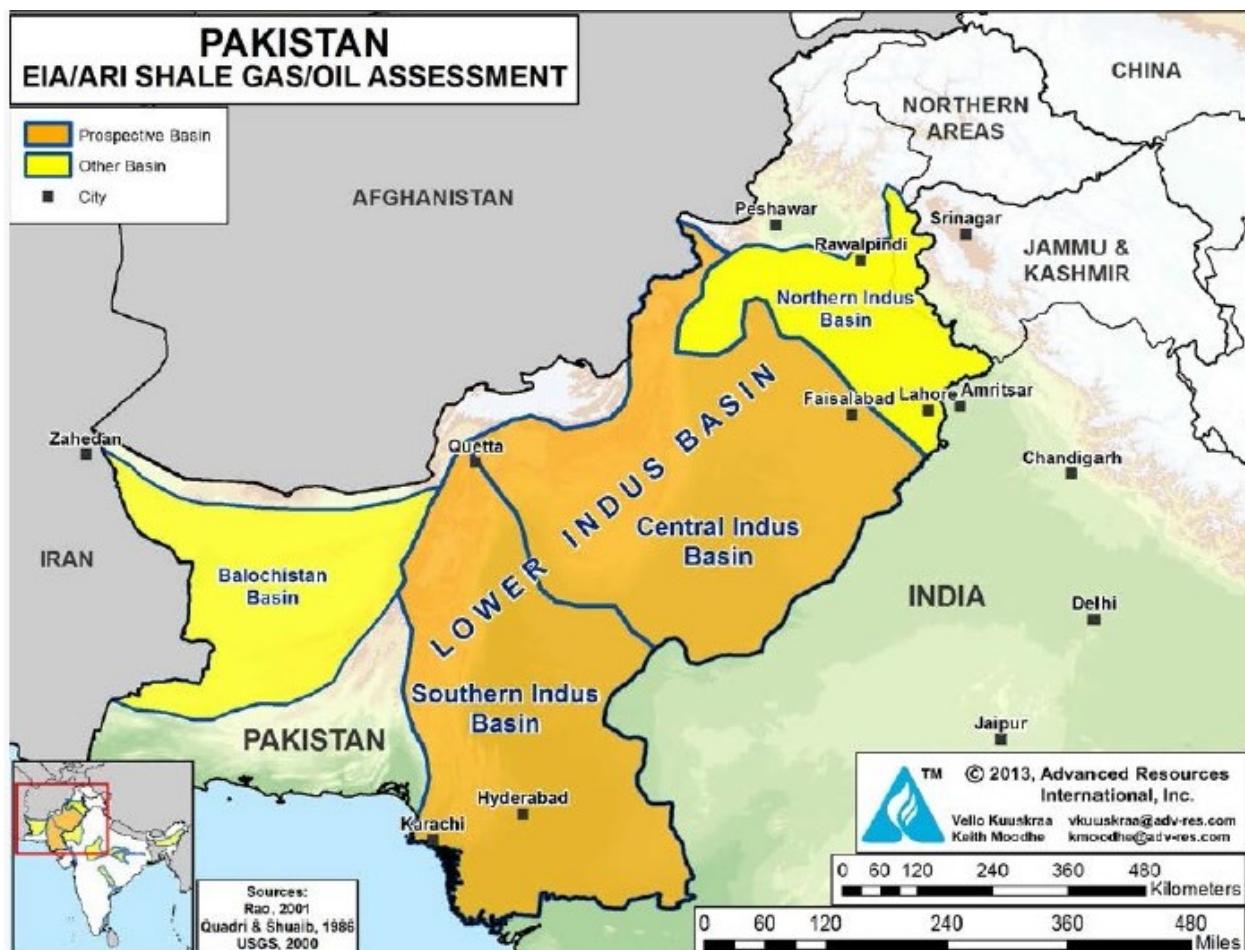


Figure 1. Shale Resource Map

The study suggests that development of the unconventional gas would be adequate to accomplish the demand of natural gas for almost 45 years at the rate of 8 MMMSCF per year and achievement in recovery efficiency of oil and gas will generate 7, 50,000 jobs throughout the country[10].

### 3. PROCESS

Initially, LPG is gelled before the fracturing to permit better transport of proppant into the fracture. When fracturing, the LPG remains liquid, but after completing the process it goes into solution with the reservoir gas.

In this method, the mixtures of light hydrocarbons are used (like propane, butane, and pentane) which have low surface tensions, viscosity, density and solubility within hydrocarbon reservoirs and have high Reid Vapour Pressure (HRVP). These characteristics are useful to develop the efficient fracture length and enhance the migration of hydrocarbons through the reservoir in the well.

The molecular formula of LPF is  $C_3H_8$ . It minimizes clean up and enhances the GASFRAC's recovery economics. The injected LPG mixes with reservoir fluid and flows back with the production fluid and we can obtain 90 – 100% of LPG recovery on processing facility.

#### 3.1. RATIONALE

Liquid propane is an appropriate fracturing fluid as its viscosity is less than water. Shale formations behave sensitively when the water interacts; therefore using LPG would avoid this problem. The Gas Frack LPG gel possesses low surface tension, low viscosity, low density, and is soluble with the reservoir fluids. These properties lead to additional effective fracture lengths and higher production rate from the well. Another advantage is the ability to evenly distribute proppant. The fracturing fluids are entirely recovered within days of stimulation, which yields greater economic and environmental advantages by reducing clean-up, waste disposal, and post-job truck traffic (Gas Frack 2013).

Water	Quantity	Liquid Petroleum Gas	Quantity
Specific gravity	1.02	specific gravity	0.51
Viscosity	0.66 cps @ (104F)	Viscosity	0.78 cps @ (103F)
Surface Tension	72 dynes/cm	Surface Tension	7.6 dynes/cm
Potentially Damaging- Reactive with clays/salts		Non-Damaging- Inert with the formation clays/salts	

Table 1: Comparison between Water and LPG

#### SURFACE FACILITIES:

The key equipment for effective LPG Fracking is as follows:

**Storage Tank:** Boost pump and nitrogen pressurization is used. The storage tanks store the LPG and LPG feed which is sent to the specialized sand blenders. To ensure safety, a pressurized nitrogen blanket is used for all storage tanks.

**Sand Blender:** This facility is pressurized with the nitrogen to purge and proppant is preloaded .A controller is installed which measures the proppant into the gelled LPG, creating LPG sand loaded slurry to stimulate the reservoir.

**Pumping Units:** These are the high-pressure pumping units that pump the slurry down the hole at specified surface pressures. Propane fracking needs specialized equipment (to perform operation under the pressures and low temperatures to keep the liquid in liquid state) and the safety systems (as propane is flammable and in order to handle emergency situations).

### 3. FACTS AND FIGURES

This method has already been utilized by Gasfrack Energy Services, a Canadian Company in Alberta, by using propane as it mixes well into formation hydrocarbon and improves performance without using water [9]. It uses a proxy for water to switch the sand/ceramics required to fracture the shale rock.

LPG is a flammable mixture and obviously, it can burn, therefore GASFRACK has proposed a closed system with zero oxygen by utilizing a specific equipment that protects the workers and requires only a minimum flaring that can be diminished to zero when appropriate recapturing facilities are installed [2] . This gives a boost to the oil and gas recovery and leads to a long-lasting production by recovering 100% of fracturing agent. Recovered LPG can be reused and resold. Propane (C<sub>3</sub>H<sub>8</sub>) is a hydrocarbon that wouldn't alter the rock formation during the process, as it has a low viscosity, low surface tension, and low density along with solubility within reservoir hydrocarbons. Due to this, it initiates an excellent fracture lengths giving greater and long term production.

The sand or proppant can be distributed while pumping; hence it decreases the proppant settling in the inconvenient areas of the formation. About 1300 wells have been fracked in Canada, however, it has to be noted that the technique was typically planned to develop the performance of low pressure wells. LPG frack saves billions of gallons of potable water that used be required in the hydraulic fracturing (as fracking a well has required 3 to 12 million gallons of water).

Figure 2 provides a visual description of comparative benefits of this system.

#### 4.1. ENVIRONMENTAL CONCERNs

LP Gas has a much positive role in the fracturing process as compared to the hydraulic fracturing, during which huge quantity of water is used which is then disposed to the impoundments and becomes a potential sources of water pollution. Environmentally, LP Fracking is highly practical as it resolves the relevant environmental issues as well as increases the oil and gas recovery efficiency by 20-30%. It eliminates the problem of getting used water as by-product which is very toxic and a major source of pollution. LPG returns at the surface are captured and recycled.

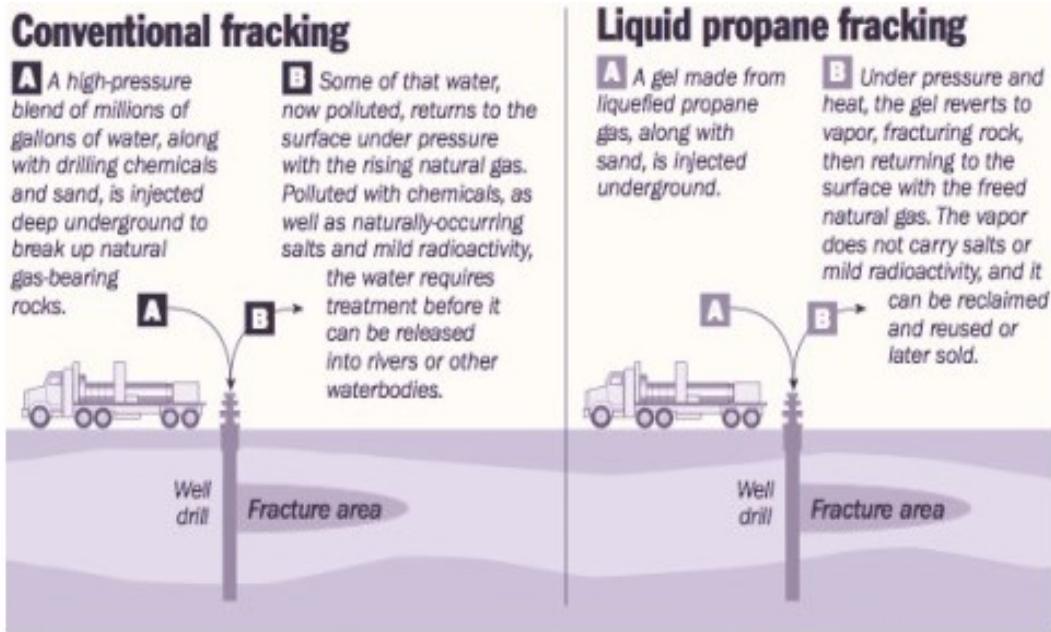


Figure 2. Benefits of LPG Fracking over Hydraulic Fracturing

## CONCLUSIONS

It is concluded that LP gas fracking can be a reliable and effective method due to following important factors:

- It has low capital cost,
- It doesn't require the use of water (only LPG gel is pumped down the well along with sand/ceramics),
- LPG gel gives desired properties i.e. low viscosity, low specific gravity, and low surface tension as compared to water which results in large fracture lengths.
- While production is in progress from the reservoir to the surface, the LPG in liquid state mixes with the production fluid (gas) and it is recaptured and reutilized for the same purpose.
- This process reduces the number of equipment required for the process and accordingly saves time, capital and maintenance expenses.
- It doesn't create water pollution as there is no water to be disposed off.
- It doesn't have an adverse effect on the health and environment as no massive shocks are generated from the earth that may become a cause for environmental disorders.

## NOMENCLATURE

LPG= Liquid propane gas,

TOC= Total Organic Content,

TCF= Trillion Cubic Feet,

USGS= United States Geological Survey,

EIA= Energy Information Administration,

USAID= United States Agency for International Development,

MMMSCF= Billion Standard Cubic Feet.

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